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Subject: 122199 Pre-telephone conference on Toxicity Testing

In preparation of a telephone conference on Toxicity Testing, w/Honeywell and the County, which has been scheduled for 12/22 at 1:00pm, I have scheduled a pre-telephone conference on 12/21 at 1:00pm. I would like to discuss our thoughts on item "2. Chronic Toxicity" of the attached document from Honeywell. As time permits we can discuss other related issues that any of the participants may have. Please confirm receipt of this email and that you will be able to participate in the telephone conference on 12/21.

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Honeywell's Position on Sediment-Related Issues for the Onondaga Lake Baseline Ecological Risk Assessment

(Received by NYSDEC from Honeywell 12/10/99)

A. Site-Specific Sediment Quality Values—Direct Toxicity

1. General Considerations

a. Why are site-specific sediment quality values needed and how can they be used to evaluate ecological risks and guide potential remedial actions?

The development of site-specific sediment quality values for Onondaga Lake is a method of 1) integrating the existing database of site-specific information on sediment chemistry, sediment toxicity, and benthic macroinvertebrate communities, and 2) producing chemical-specific concentrations that can be used to provide realistic estimates of potential risk (as opposed to screening-level estimates) to ecological receptors under the site-specific conditions found in the lake.

The sediment quality values can be used to delineate areas of potential concern and to develop remedial action objectives. For example, Oak Ridge National Laboratory (ORNL and Jacobs Engineering 1996) recently used the apparent effects threshold (AET) approach applied to sediment toxicity data on amphipod (*Hyalella azteca*) survival to develop site-specific remedial goal options for arsenic, mercury, nickel, silver, and total polychlorinated biphenyls (PCBs) in sediments of Poplar Creek, Tennessee.

b. Is the AET approach appropriate for site-specific use in Onondaga Lake?

The AET approach was subjected to a detailed technical review by the U.S. Environmental Protection Agency (EPA) Science Advisory Board, which concluded that the method contains sufficient scientific merit for estimating sediment quality at specific sites (U.S. EPA 1989). By contrast, most other methods of sediment quality development have not been subjected to such a critical and rigorous review by EPA, including the methods of Long and Morgan (1991) and Persaud et al. (1993).

c. How can the AET approach be used to set multiple kinds of sediment quality values to aid decision-making?

The AET approach is designed to calculate chemical-specific sediment quality values for individual biological endpoints. Therefore, multiple AET values can be developed for each chemical of concern, allowing a risk manager considerable flexibility with how these values are used for such purposes as identifying and prioritizing potential problem areas and developing remedial action objectives.

For example, for each chemical considered in the Onondaga Lake baseline ecological risk assessment (BERA), AET values were calculated for five distinct endpoints (i.e., amphipod survival, amphipod growth, chironomid survival, chironomid growth, and benthic community alterations). Therefore, five site-specific AET values were available for each chemical, providing flexibility in how they were combined to develop different kinds of site-specific sediment quality values for risk assessment. For each chemical, primary and secondary Onondaga Lake sediment quality values (OLSQVs) were developed to provide independent assessments of lethal and sublethal sediment toxicity (respectively). These two categories allowed potential areas of concern to be evaluated and ranked with respect to the potential severity of predicted sediment toxicity, which could lead to different kinds of remedial decisions.

d. Is the quality of the 1992 biological data for the lake appropriate for use?

As discussed at the April 15, 1999, meeting with the New York State Department of Environmental Conservation (NYSDEC), Honeywell believes that data collected on benthic macroinvertebrate communities and sediment toxicity during the BERA have been subjected to appropriate quality assurance/quality control (QA/QC) evaluations and are adequate for use in the BERA. In their alternate evaluation of the benthic macroinvertebrate data based on benthic metrics (Larson 1999, pers. comm.), NYSDEC stated that the quality of the BERA benthic data appears to be good, the methods appear sound, the numbers of individuals and species are within the expected ranges for benthic samples, and the taxonomic proficiency is acceptable. It therefore appears that the only QA/QC issues are related to the sediment toxicity tests. Honeywell is willing to work with NYSDEC to resolve these issues in a mutually agreeable manner so that these important data can be used in the BERA.

e. What additional data are needed?

At the request of NYSDEC, Honeywell will collect additional data on sediment chemistry and long-term sediment toxicity.

2. Chronic Toxicity

a. Are benthic macroinvertebrate community data appropriate for assessing

chronic toxicity?

Because benthic macroinvertebrates spend most or all of their life cycles in close contact with sediment, the characteristics of benthic macroinvertebrate communities represent the results of chronic exposure to chemical contaminants in the sediment. Because of their relatively stationary nature and close contact with the sediment, benthic macroinvertebrate community evaluations have been routinely recommended as one of the best tools for assessing sediment toxicity (e.g., La Point and Fairchild 1992; Rosenberg and Resh 1993; U.S. EPA 1997).

b. What protocols should be used for chronic sediment toxicity tests?

- **Test species and endpoints**
- **Test duration**
- **Exposure conditions (e.g., water quality characteristics, static/flow-through regimes)**

Honeywell has strong reservations about the use of the draft long-term sediment toxicity protocols for the amphipod (*Hyalella azteca*) and chironomid (*Chironomus tentans*) tests being developed by EPA. We believe that it is premature to use these draft protocols for real-world decision-making. Neither of the protocols are yet finalized nor have they been field validated in any manner. The lack of field validation is particularly disturbing because this kind of information is essential to understanding how well the toxicity test results correspond to effects on benthic macroinvertebrate communities in the field. This kind of information is critical for selecting a meaningful sediment toxicity test. For example, U.S. EPA (1994) stated that toxicity testing methods should be "confirmed with responses with natural populations of benthic organisms." We are concerned that using the draft, largely experimental protocols may produce results that are experimental artifacts unrelated to chemical toxicity or with little ecological relevance.

If a long-term test is used for Onondaga Lake, Honeywell proposes that the 42-day amphipod test based on *Hyalella azteca* be selected. This protocol is preferable to the chironomid test because it is based on only a slight modification of the 28-day protocol developed by ASTM (1997), and therefore has a higher likelihood of providing meaningful results. The proposed test endpoints are survival, growth, and reproduction. As stated in the protocol, "for site-specific evaluations, the characteristics of the overlying water should be as similar as possible to the site where sediment is collected." Therefore, it is recommended that the pH and water hardness of the test water be similar to the values typically found in Onondaga Lake.

c. How should the toxicity data be analyzed and interpreted?

The toxicity results should be evaluated by statistical comparisons with the results of tests conducted on sediments from the project reference lake (Otisco Lake). Benthic macroinvertebrate and sediment chemistry samples should be collected synoptically with the sediment used for toxicity testing to allow a complete triad analysis to be conducted as a key component of the interpretation methods. To maintain consistency with the BERA and to ensure that all benthic macroinvertebrate samples are collected within the same depth stratum, all triad samples will be collected at a water depth of 1.5 m.

3. Benthic Macroinvertebrate Analysis

NYSDEC conducted an independent analysis of the benthic macroinvertebrate data collected in Onondaga Lake during the BERA (Larson 1999, pers. comm.). The analysis focused on the 31 stations located at a depth of 1.5 m around the littoral zone of the lake and was based on the use of various benthic metrics.

Based on a review of the NYSDEC analysis, it appears that its objective differed somewhat from that of the BERA. The objective of the NYSDEC analysis appeared to be to identify stations at which benthic communities were impaired, regardless of the cause of the observed impairment. By contrast, the objective of the BERA was to identify stations at which benthic communities were impaired most likely from exposure to toxic chemicals (i.e., as opposed to other factors such as habitat alterations, eutrophication, and predation).

Because Onondaga Lake is hypereutrophic, there are numerous eutrophication-related factors that could result in lakewide impairment of benthic communities. In fact, two of the four metrics used by NYSDEC (i.e., reduced species richness and increased percent oligochaetes) are classic indicators of the effects of eutrophication (Wiederholm 1980; U.S. EPA 1990). In addition, the other two indicators used by NYSDEC correlated significantly with the first two indicators (i.e., $r_s=0.84$ for species richness and non-Chironomidae/Oligochaeta species, and $r_s=0.74$ for percent oligochaetes and dominance), suggesting that they may also have been responding primarily to the eutrophic conditions in the lake.

Because hypereutrophic conditions can affect benthic communities throughout Onondaga Lake, the benthic analyses used in the BERA were designed not only to identify impaired stations, but also to identify those stations where impairment was likely due to toxic chemicals. The details of those analyses are discussed below.

a. What methods of analysis should be used?

- **Community metrics (e.g., taxa richness and diversity)**

- **Multivariate analysis (e.g., classification analysis)**

Honeywell agrees with NYSDEC that both kinds of analysis provide important information in evaluating benthic macroinvertebrate communities. However, for the two kinds of analyses conducted for the shallowest 31 stations in Onondaga Lake, the results based on classification analysis in the BERA agree more closely with the sediment toxicity results than do the results of the metrics analysis conducted by NYSDEC.

For example, the level of agreement between the benthic and toxicity analyses on the presence or absence of adverse effects at the 31 stations was 74 percent (i.e., 23 of the 31 stations) based on the classification analysis and only 42 percent (i.e., 13 of the 31 stations) based on the metrics analysis. The value of 74 percent agreement was statistically significant (P0.05, binomial test) compared to a value of 50 percent based on random agreement. By contrast, the value of 42 percent agreement was lower than the value expected based on randomness alone. Most of the station misclassifications based on the metrics analysis (12 of the 18 stations were misclassified) were the result of benthic evaluations that identified effects which were not found during toxicity testing. This pattern is consistent with the above suggestion that the metrics analysis identified impairment based on toxic chemicals and other factors (e.g., habitat alterations, eutrophication, and predation), rather than on toxic chemicals alone.

b. How can effects due to toxics be separated from effects due to other factors?

- **Reference area comparisons**

- **Depth stratification**

- **Triad analysis (i.e., synthesis of the benthic results with those for sediment chemistry and sediment toxicity)**

The potential for confounding factors to influence the results of the benthic community analyses conducted in the BERA was minimized by 1) using an independent and upstream reference area as the standard for determining adverse effects, 2) stratifying benthic stations by depth, and 3) using the triad analysis to link observed benthic community alterations with elevated chemical concentrations and sediment toxicity. The details of these methods are described below.

Benthic effects were determined in the BERA by comparisons of community characteristics with a reference area (Otisco Lake). A reference area outside of Onondaga Lake was used (i.e., as opposed to an in-lake reference area) because benthic communities throughout Onondaga Lake were expected to be altered to some degree by lakewide stressors resulting from the hypereutrophic state of the lake.

Because the characteristics of benthic communities are known to vary with depth, benthic sampling in both Onondaga and Otisco lakes was stratified into four depth intervals (1.5, 4.5, 7.5, and >7.5 m) and community comparisons were made only within each interval. Note that no comparisons could be made for depths >7.5 m because virtually no benthic macroinvertebrates were found at those depths in Onondaga Lake because of anoxic conditions in the hypolimnion.

Based on the results of an interagency workshop on the triad approach convened by the National Oceanic and Atmospheric Administration (Chapman et al. 1997), an approach was recommended for "sediment quality assessment designed to determine 1) the existence and extent of benthic ecosystem degradation, and 2) the cause(s) of that degradation, including specifically chemical contamination." These uses of the triad approach directly match the previously stated objective of the BERA to identify stations where impairment of the benthic communities in Onondaga Lake most likely occurred because of exposure to toxic chemicals.

The basic premise of the triad approach is that no single indicator can be used alone to reliably identify stations where toxic chemicals pose an ecological risk, primarily because each indicator has some kind of limitation:

> **Sediment Chemistry**—Although this information identifies stations where chemical concentrations are elevated, it does not indicate whether the chemicals are sufficiently bioavailable to result in adverse biological effects.
>
> **Sediment Toxicity Tests**—Although this information identifies stations where chemical concentrations may be sufficiently elevated and bioavailable to result in adverse biological effects, it does not provide conclusive evidence that adverse effects will be found in indigenous populations and communities in the field.
>
> **Benthic Macroinvertebrate Communities**—Although this information identifies stations where adverse effects are found in indigenous populations and communities in the field, it does not provide conclusive evidence that the adverse effects are the result of toxic chemicals (i.e., as opposed to other factors such as habitat alterations, eutrophication, and predation).

Given the limitations encountered with each of the individual triad indicators, all three

kinds of indicators must be evaluated in conjunction with each other to provide accurate estimates of sediment quality. The use of multiple lines of evidence to evaluate potential ecological risk is consistent with the most recent guidance on ecological risk assessment provided by U.S. EPA (1997, 1998, 1999).

Because a high degree of agreement was found between benthic community alterations and sediment toxicity in the BERA (i.e., 74 percent, see above discussion), it was concluded that these two indicators were identifying biological effects due primarily to toxic chemicals. In addition, to identify stations of potential concern, it was required that the biological and chemical information agree as closely as possible. In this manner, use of the triad approach ensured that any observed adverse biological effects were most likely the result of toxic chemicals.

4. Effects of Lake Recovery on Sediment Toxicity

In response to requests by NYSDEC, Honeywell is currently evaluating potential effects of water quality improvements in Onondaga Lake on the resident benthic macroinvertebrate communities. Some of the major factors being considered are listed below. To ensure that all of NYSDEC's concerns are addressed and that agreement is reached on the likely extent of future improvements, we would like to discuss the items listed below, as well as any other items that may be of concern.

Improved water-column conditions in the hypolimnion

- Increased concentrations of dissolved oxygen
- Decreased concentrations of sulfide

Improved sediment conditions

- Modifications of sediment total organic carbon
- Modifications of sediment acid volatile sulfides
- Modifications of sediment ammonia and sulfide

B. Site-Specific Sediment Quality Values—Bioaccumulation

[Honeywell's positions on these issues are currently being developed.]

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